

## **THE U.S. ARMY SAFELOAD EXPLOSIVES SAFETY PROGRAM**

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### **ABSTRACT**

The Safeload Program is designed to provide soldier-ready solutions that minimize existing explosive hazards and risks. The Safeload Program replaces a program called Quickload, which was started in 1984 to provide interim solutions to unsafe storage of basic loads of ammunition in ammunition holding areas in South Korea. While Quickload primarily focused on Korea, and secondarily on Europe, the Safeload Program addresses explosives safety problems in all theaters. Safeload solutions can be divided into two distinct categories: propagation control solutions and improvements to explosives safety technology. The program is an important part of the ammunition logistics objective: getting ammunition to the soldier. Explosives safety regulations tend to become a constraint to an organization's capability. By finding ways to remove these hurdles, Safeload increases an organization's flexibility, productivity, efficiency, effectiveness and safety.

### **INTRODUCTION**

Operations Desert Shield and Desert Storm were the ultimate test of the Army's ability to quickly move huge quantities of ammunition from depots in the United States and storage locations overseas to combat forces deployed in a theater of operations. An extremely important element of ammunition logistics, particularly during a conflict, is the need for safety in both moving and storing ammunition. U.S. Army ammunition is well-known throughout the world as safe and thoroughly tested. However, if explosives safety standards are not considered when ammunition is stored in the field, the potential for a mishap increases, often with catastrophic results.

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An accident at the close of Operation Desert Storm illustrates the importance of safety. At Camp Doha, Kuwait, a fire on a field artillery ammunition support vehicle detonated ammunition on the ground and in other vehicles. In the resulting explosion, 58 soldiers were injured, 84 vehicles destroyed, and 77 vehicles damaged. In all, more than \$40 million worth of supplies, property, and equipment was lost. Several days later, two soldiers were killed and one injured when an explosion occurred during cleanup at the accident site.

After-action interviews revealed that the ammunition storage practices that led to this accident were not unusual. The potential danger was exacerbated by insufficient storage space for the large amounts of ammunition. Even with Saudi Arabia's large land mass in which to operate, security considerations and operational necessity often reduced the size of munition storage areas. The result was that explosives safety suffered. In sum, this was a classic case of how and why a real time explosives safety strategy is the commander's best friend in ensuring the availability and survivability of a precious asset.

#### **AMMUNITION SAFETY PROGRAMS**

Improvements to the \$20-billion ammunition logistics system are the responsibility of the Project Manager for Ammunition Logistics (PM-AMMOLOG). PM-AMMOLOG has two programs for improving the overall safety of the ammunition logistics system: the Safeload Explosives Safety Program and the Explosives Safety Improvement Technology Program. The Safeload Program, funded by operation and maintenance, Army, appropriations, is designed to provide soldier-ready solutions that minimize existing explosives hazards and risks. It was created to respond directly to needs communicated from the field. A listing of Safeload Program projects are contained in figure 1. The Explosives Safety Improvement Technology Program, on the other hand, develops technology for safer munitions packaging and improved explosives safety for subsequent transition into the Safeload Program. It is funded by research, development, test, and evaluation appropriations.

The Safeload Program replaces a program called Quickload, which was started in 1984 to provide interim solutions to the unsafe storage of basic loads of ammunition in ammunition-holding areas in South Korea. While the original Quickload Program primarily focused on Korea, and secondarily on Europe, the Safeload Program addresses explosives safety problems in all theaters.

By reducing hazards and associated risks for our soldiers, the Safeload Program improves the survivability, operability, and sustainability of the ammunition logistics system. Survivability is strengthened because munitions that are safely stored can survive accidents and enemy attack. Operability is enhanced because, by using denser storage configurations and reducing safety-imposed constraints, limited storage space is freed for other purposes. Sustainability is upgraded because ammunition is safer to transport and can be stored uploaded and ready for movement at overseas depots. The payoff from Safeload advances is reduced safety violations, reduced hazard risks, and a safer flow of ammunition through the ammunition logistics system.

The Safeload Program complements the Army's Insensitive Munitions (IM) Program. While Safeload focuses on munitions in the current inventory, the IM Program develops less-sensitive high explosives and propellants, mitigation devices, and improved packaging. These improvements will result in munitions that will react less violently to unplanned stimuli. As new munitions incorporating these IM advances enter the inventory, they will enhance the explosives safety storage benefits provided by Safeload. The contributions of both the Safeload and IM Programs will result in the highest level of safety and survivability.

#### **HOW SAFELOAD WORKS**

New ideas for programs to address soldiers' explosives safety concerns are always solicited from the field. These concerns, along with potential solutions, are forwarded to the Army's major commands to determine the extent of user interest and applicability. Project funding is then requested for those projects that are needed and have support. All solutions to explosives safety problems are developed by PM-AMMOLOG in close coordination with the Army Technical Center for Explosives Safety and the Department of Defense Explosives Safety Board; those organizations must approve all solutions before they are implemented. Strong support is provided by the Army Training and Doctrine Command's Munitions System Manager. PM-AMMOLOG manages the projects and selects activities within the explosives safety community to execute individual projects, based on cost, scheduling, and performance factors.

Safeload solutions can be divided into two distinct categories: propagation control solutions and improvements to explosives safety technology. Propagation control solutions prevent an unplanned detonation from spreading to other munitions, which will greatly reduce the size of an accident and prevent a potential catastrophe. Typical propagation control

solutions include ammunition racks that store munitions or barricades that are placed between stacks of munitions.

Improvements to explosives safety technology which are now being planned include a computerized explosives site-planning program and a project to improve personnel protection from hazard division 1.3 explosive remote operations (which are mass-fire-producing items such as propellants and infrared flare mix). Other efforts, suggested by the U.S. Army, Japan's 83d Ordnance Battalion, include methods of using natural terrain (such as hills and cliffs) to reduce hazard zones; determining the TNT equivalency of propellants; and determining if the blast waves from improperly stored ammunition will coalesce.

A number of other projects identified by the explosives safety community are being considered for future efforts. These include portable safety boxes for arms-room storage of 75-millimeter salute cartridges; barricades to improve safety at ports during deployment; and energy-absorbing barricades to dissipate blast forces during accidents. The feasibility of these concepts is currently being evaluated.

#### **CURRENT SAFELOAD PROJECTS**

A number of successful solutions have already been completed and distributed to the field under the SafeLoad Program. Technical data packages containing detailed information are available by writing to--Director, U.S. Army Technical Center for Explosives Safety, ATTN: SMCAC-ESL, Savanna, IL 61074-9639. The applicability of these solutions to specific wartime or peacetime scenarios must be determined by the using organization. Many of these solutions were developed by the Army Ballistic Research Laboratory at Aberdeen Proving Ground, Maryland. They include ammunition storage racks for downloaded tank ammunition, a sand grid wall, a method for storing mixed munitions in a conex container; a TOW missile rack; and a 4.2-inch mortar rack.

The tank ammunition storage racks, figure 2, permit the safe storage of downloaded tank ammunition during periods of vehicle maintenance or unit training. Previously, the ammunition was simply removed from the tank and temporarily piled on the ground. The racks reduce the hazard radius for 105-millimeter ammunition from 1,200 feet to 50 feet, and the radius for 120-millimeter ammunition from 800 to 75 feet. These reductions in hazard radius are important when storage space is at a premium.

The sand grid wall, figure 3, allows truckloads of nearly all types of 155-millimeter artillery ammunition to be safely

stored with only a 15-foot separation between trucks. This is a substantial reduction from the standards in current safety regulations, which require a separation of 150 feet between trucks if unbarricaded and 82 feet if standard above-ground barriers are used (see figure 4). By placing the sand grid wall between up-loaded trucks, up to 160 155-millimeter projectiles and an equivalent number of propellant charges can be stored on each truck. Sand grid walls are inexpensive, can be built by unskilled labor, and can be collapsed so they take up little storage space when not in use.

The Ballistic Research Laboratory has also developed a technical data package that describes a method for storing up to 500 pounds of hazard division 1.1 (mass-detonating items) bulk high-explosives or demolition material in a fixed conex container. With this method, the hazard radius for these materials is reduced from 1,250 feet to only 360 feet. Certain small-caliber ammunition, smoke grenades, ground illumination signals, and a file destroyer may also be stored in the container. This storage method also allows the space between conex containers in storage to be reduced from 96 feet to only 8 feet.

The TOW missile rack, figure 5, is used in a fixed conex container to reduce the size of an explosion and prevent mass detonations. The TOW rack reduces the hazard radius from 1,250 feet to only 350 feet, except at the door, where 740 feet is required for a 60 degree arc. Use of the rack reduces the land required to store 1 conex container full of TOW missiles from 113 acres to 14 acres.

The 4.2-inch mortar rack, figure 6, provides safe storage for 48 high-explosive mortar projectiles in a fixed conex container. Use of the rack reduces the hazard radius from 1,250 feet to only 100 feet, except at the door, where 310 feet is required for a 30 degree arc. The result is a reduction in land required from 113 acres to only 1 acre (see figure 7). The rack consists of simple wooden modules made of common lumber that are stacked inside a conex container to prevent round-to-round propagation. Plastic bottles filled with fire suppressive liquid are placed inside the modules. During an accident, the bottles will rupture, coating all wood with a fire preventative that inhibits cook-offs or secondary fires.

#### **COMING SOLUTIONS**

During 1993, additional solutions will become available to reduce hazards throughout the logistics system.

The Huntsville (Alabama) Division of the Army Corps of Engineers will produce three designs for small earth-covered magazines. These miniature magazines, or minimags, will provide secure storage for small quantities of munitions or explosives. They could be used to store explosive ordnance disposal operational loads and K-9 explosive scent kits; separate small quantities of incompatible items; or temporarily store amnesty items or munitions awaiting demilitarization. They could also be used by the research and development community. The magazines will be relatively inexpensive to build and will significantly reduce hazard-zone requirements. The magazines will also feature separated compartments to allow storage of ammunition from different compatibility groups.

A wartime storage risk analysis being performed at the Army Corps of Engineers' Waterways Experiment Station in Vicksburg, Mississippi, will provide numerical risk factors to help commanders make informed decisions when they must store ammunition closer together and closer to inhabited buildings than safety regulations permit. The need for these risk factors was suggested by soldiers participating in Operations Desert Shield and Desert Storm.

The Waterways Experiment Station is also developing a method of storing trucks or trailers uploaded with 155-millimeter artillery ammunition in excavated, covered trenches (see figure 8). The ammunition trucks will be parked rear-to-rear in the trenches, with a sand-wall barrier between them. This will allow trucks to be stored only 10 feet apart, instead of the normal, unbarricaded requirement of 150 feet. Trench storage will provide inexpensive and rapid construction, reduce hazard radiuses, and improve survivability from enemy fire. It will be ideal for desert environments since it provides camouflage and protects against sand and dust.

Troops routinely build sandbag walls between basic-load ammunition stored in the open, in vehicles, on trailers, or in conex containers. However, despite their widespread use, sandbag walls have many problems. Filling sandbags is slow work and requires much labor. Once sandbag walls are built, exposure to sunlight rapidly decomposes the sandbags and the walls quickly lose stability. In response to these problems, the Waterways Experiment Station is developing procedures for building a new type of sand or earth wall, called geosynthetic reinforced walls (see figure 9). Compared to sandbag walls, geosynthetic walls can be built at 1/3 the cost and in 1/8 the time, using materials that require only 1/8 the storage room, and will last 10 to 40 times longer. A step-by-step videotape and technical data

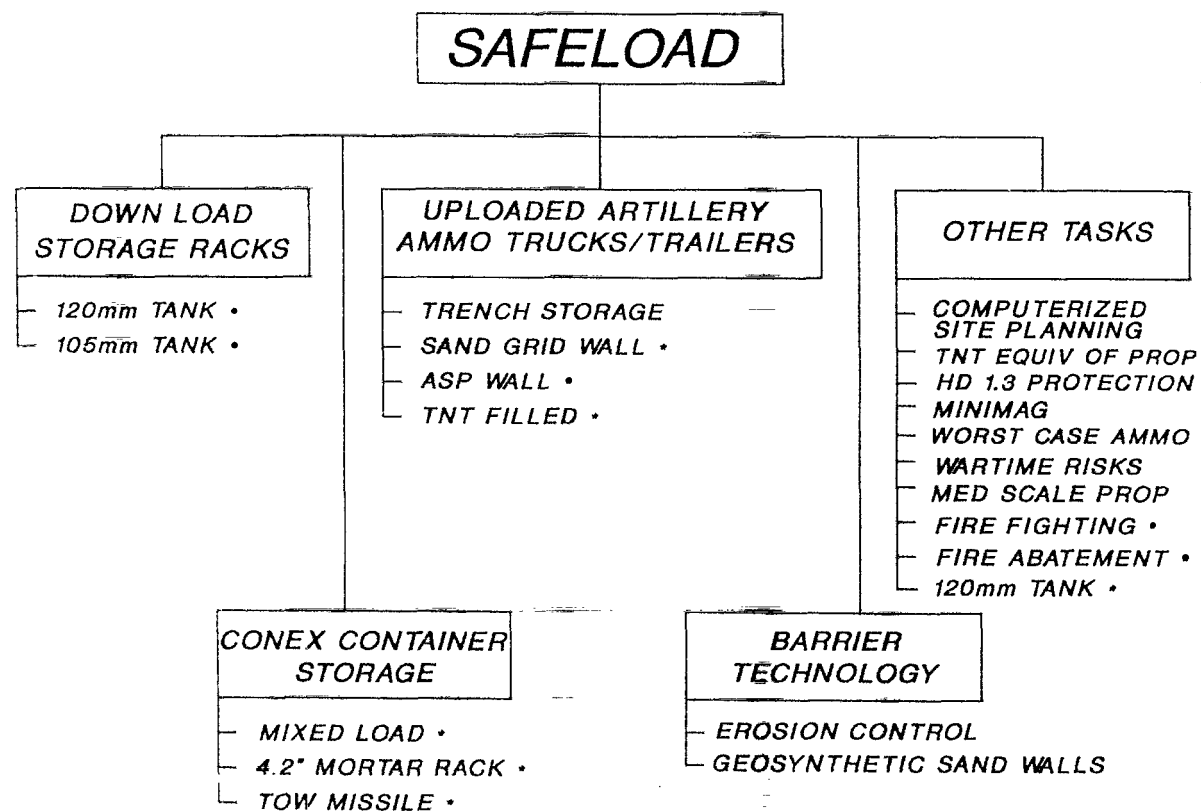
package will soon be available to demonstrate geosynthetic reinforced-wall construction techniques.

During Operations Desert Shield and Desert Storm, ammunition was stored in the open at ammunition supply points in Saudia Arabia. Attempts to construct sand barricades between ammunition stacks to prevent explosive propagation were frustrated by strong desert winds, which simply blew the barricades away (see figure 10a). In response, the Waterways Experiment Station is developing lightweight, portable, easily installed devices that will prevent the wind erosion of sand-term barricades used between basic-load ammunition in desert environments (see figure 10b). A step-by-step videotape and technical data package will be available to demonstrate the different erosion control techniques.

The PM-AMMOLOG's Safeload Program is an important part of the overall ammunition logistics objective: getting ammunition to the soldier. Explosives safety regulations tend to become a constraint to an organization's operational capability. By finding ways to remove these hurdles, Safeload increases an organization's flexibility, productivity, efficiency, and effectiveness. In short, explosives safety consciousness can be a significant force multiplier.

The Safeload program is designed to meet user needs and seek answers to soldier's explosives safety concerns. New ideas for future Safeload projects are encouraged and should be sent to the Office of the Project Manager for Ammunition Logistics, ATTN: AMCPM-AL, Building 455, Picatinny Arsenal, NJ 07806-5000. Together, we can make explosives safety a low-risk enterprise.





• COMPLETED PROJECTS

Figure 1. Projects in the Safeload Explosives Safety Program

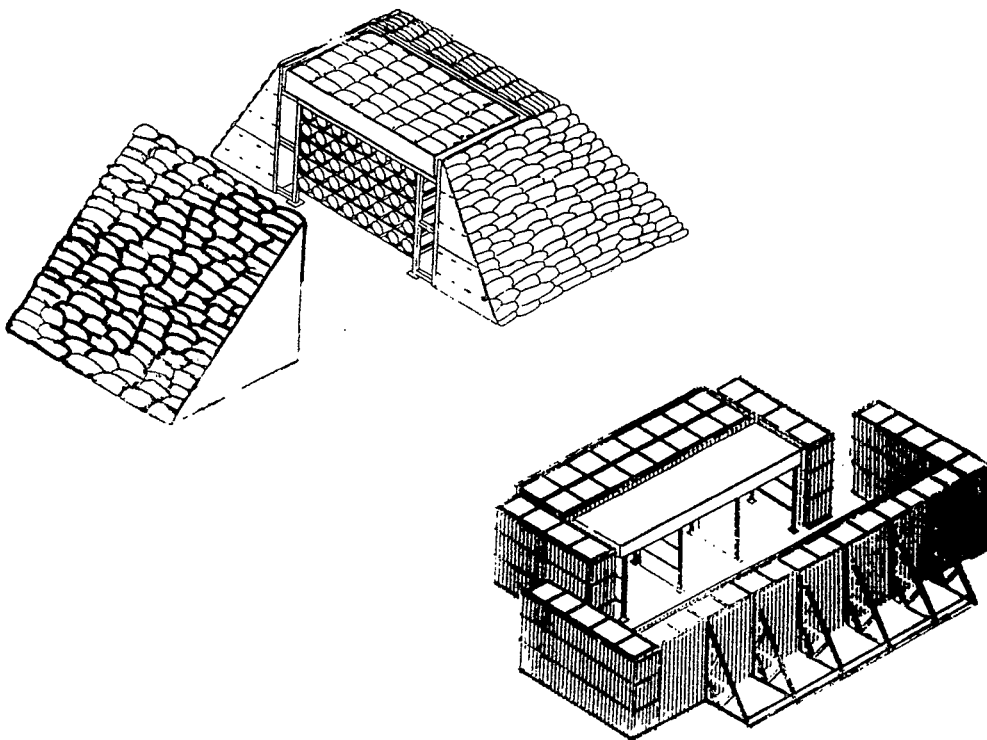


Figure 2. 105mm and 120mm Tank Ammunition Racks Provide Safe Storage During Maintenance or Unit Training

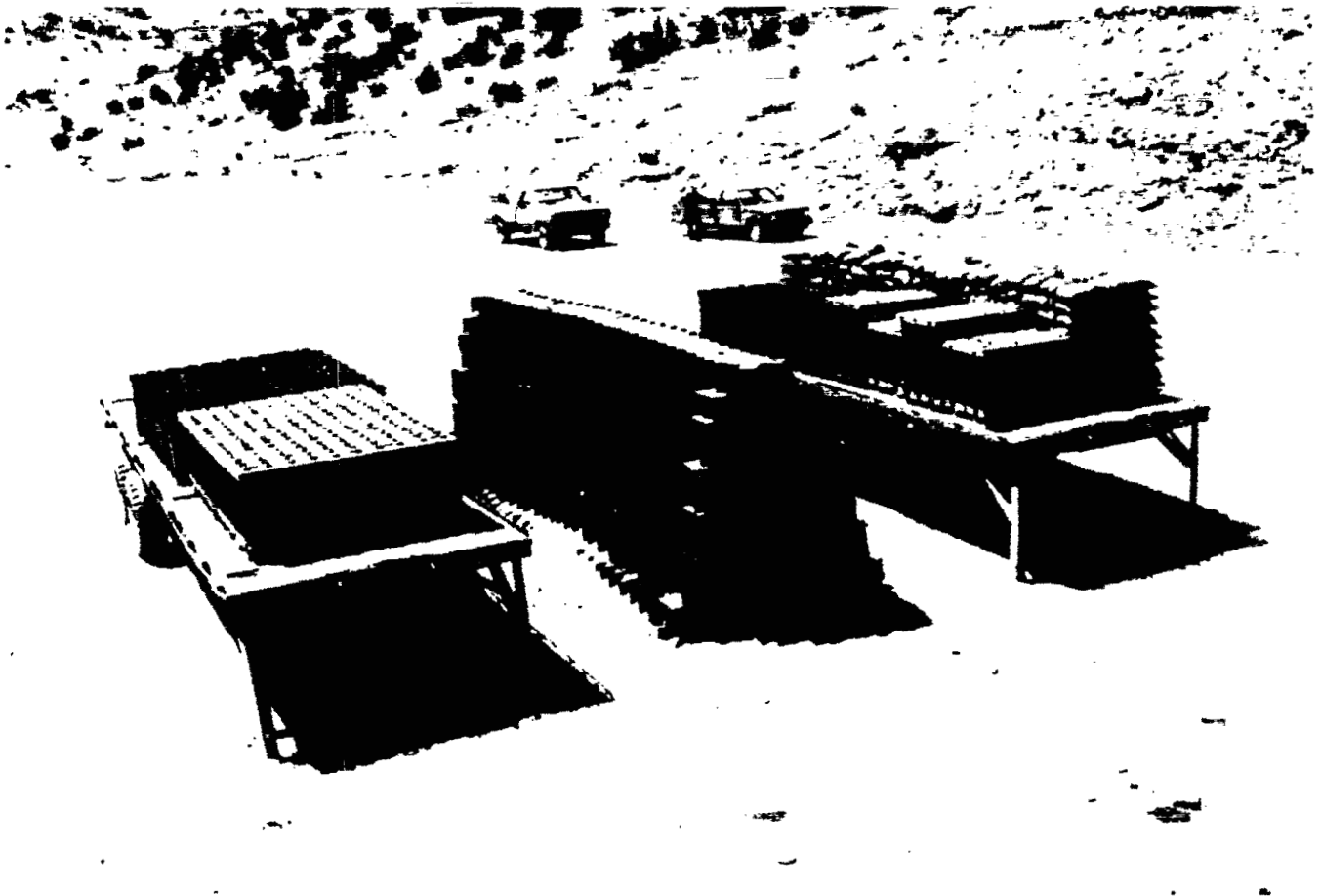


Figure 3. The Sand Grid Wall Prevents Explosive Propagation  
Allowing Loaded Ammunition Trucks To Be Closely Parked

**SAND GRID WALL QUANTITY-DISTANCE REDUCTION  
TRUCKS UPLOADED WITH 155MM ARTILLERY AMMO  
2500 LBS. HE/TRUCK  
AMMUNITION SEPARATION DISTANCE**

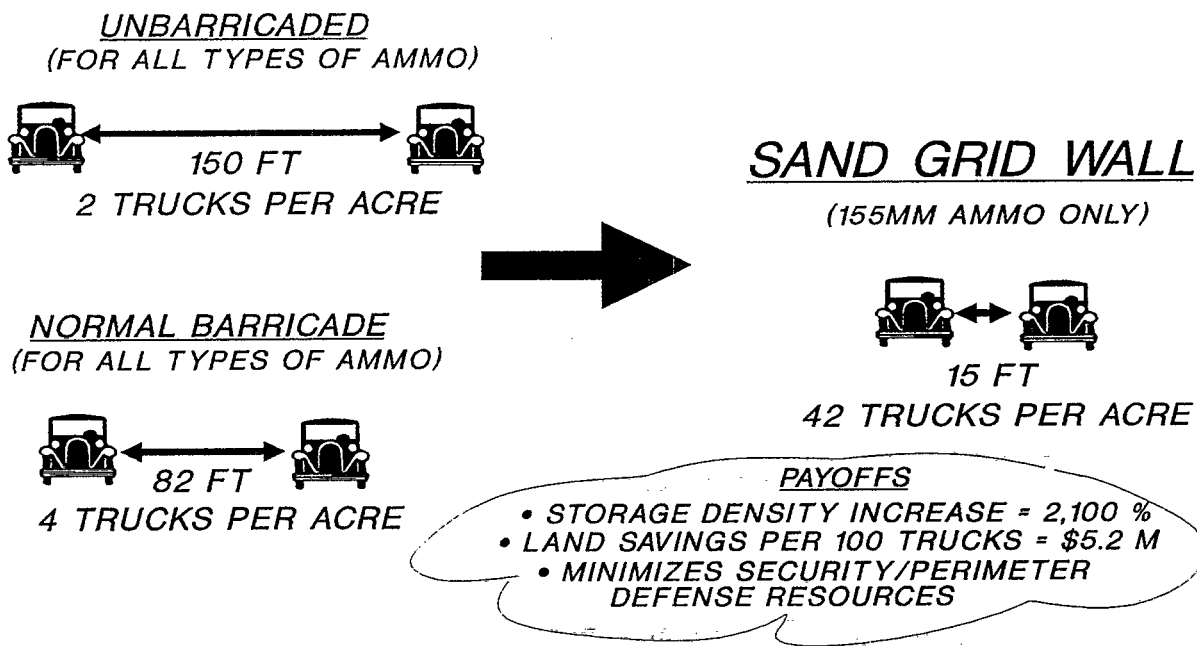


Figure 4. Operational Benefits of the Sand Grid Wall Barricade

STOWAGE DIAGRAM  
15 STACKING MODULES REQUIRED  
(12" CONFIGURATION)

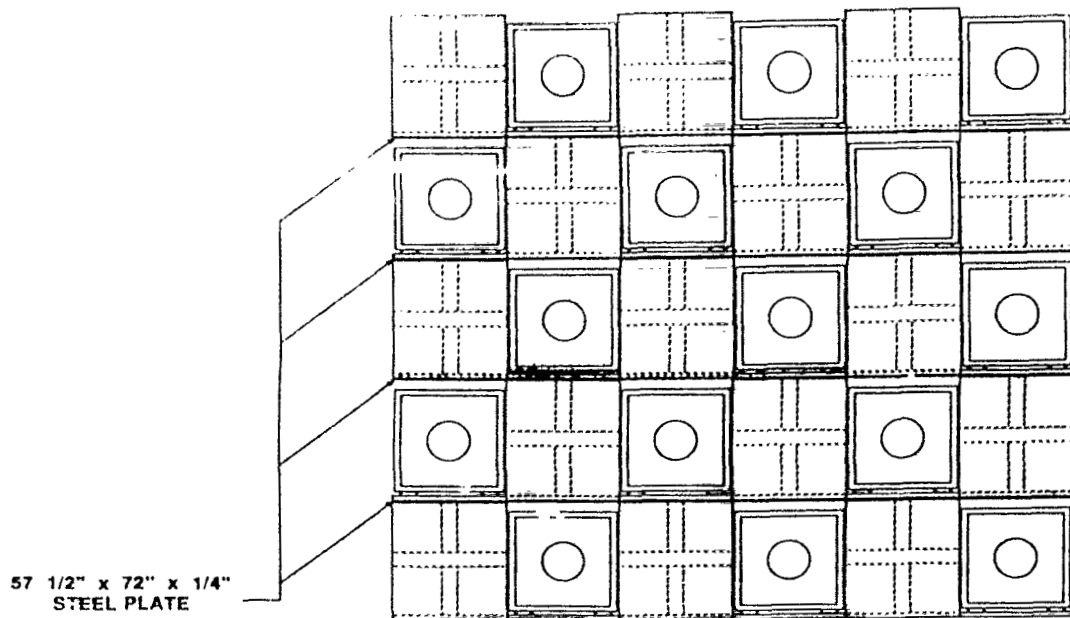


Figure 5. The TOW Missile Rack Provides Safer Storage in Conex Containers

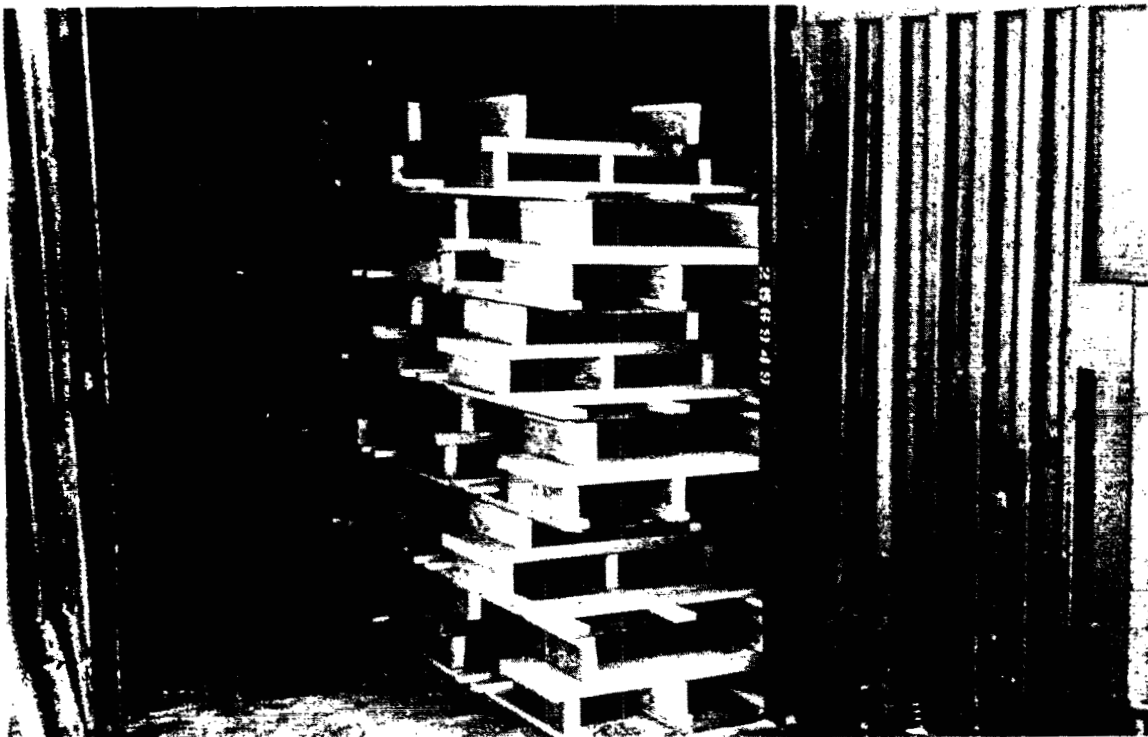
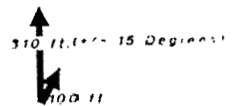
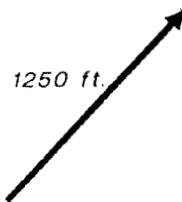


Figure 6. The 4.2 Inch Mortar Rack Provides Safer Storage in a  
Conex Container

# QUANTITY DISTANCE REDUCTION STORAGE OF 48 HE FILLED 4.2" MORTARS INHABITED BUILDING DISTANCE

CONEX WITHOUT RACK

CONEX WITH RACK



REQUIRES 113 ACRES  
ENCUMBERED LAND

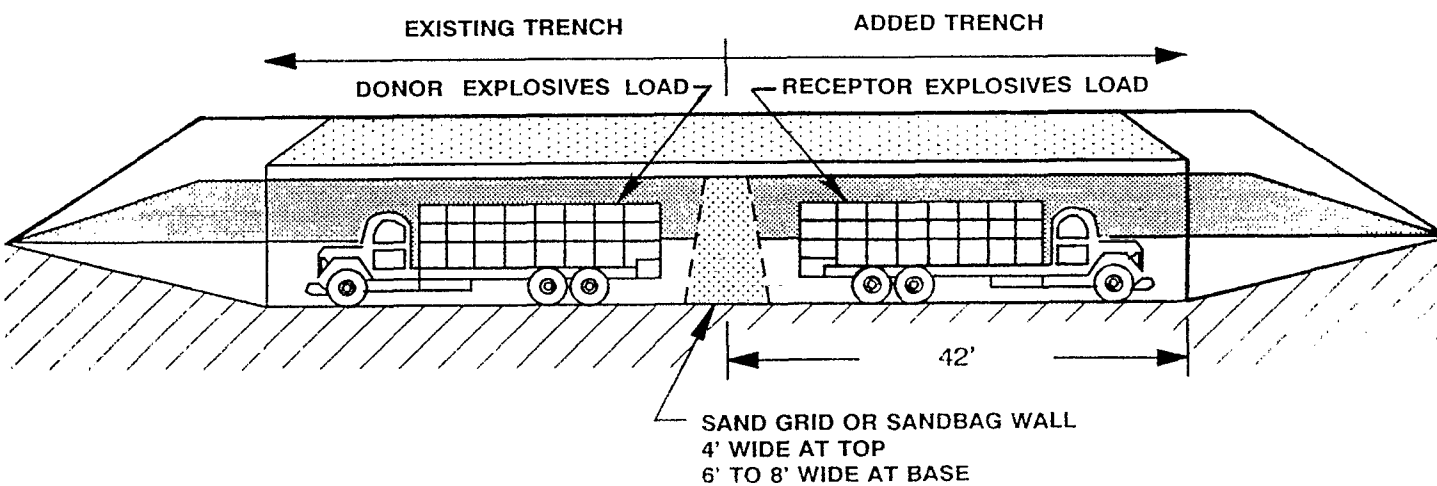
REQUIRES 1 ACRE  
ENCUMBERED LAND

## PAYOFFS

- STORAGE DENSITY INCREASE = 11,200 %
- LAND SAVINGS PER CONEX = \$11.2 M

Figure 7. Hazard Zone Reduction Provided By The 4.2" Mortar Rack

**TRENCH STORAGE TEST 3  
DUGWAY PROVING GROUND**



**TEST CROSS-SECTION**

Figure 8. Trench Storage Provides Improved Safety And Survivability



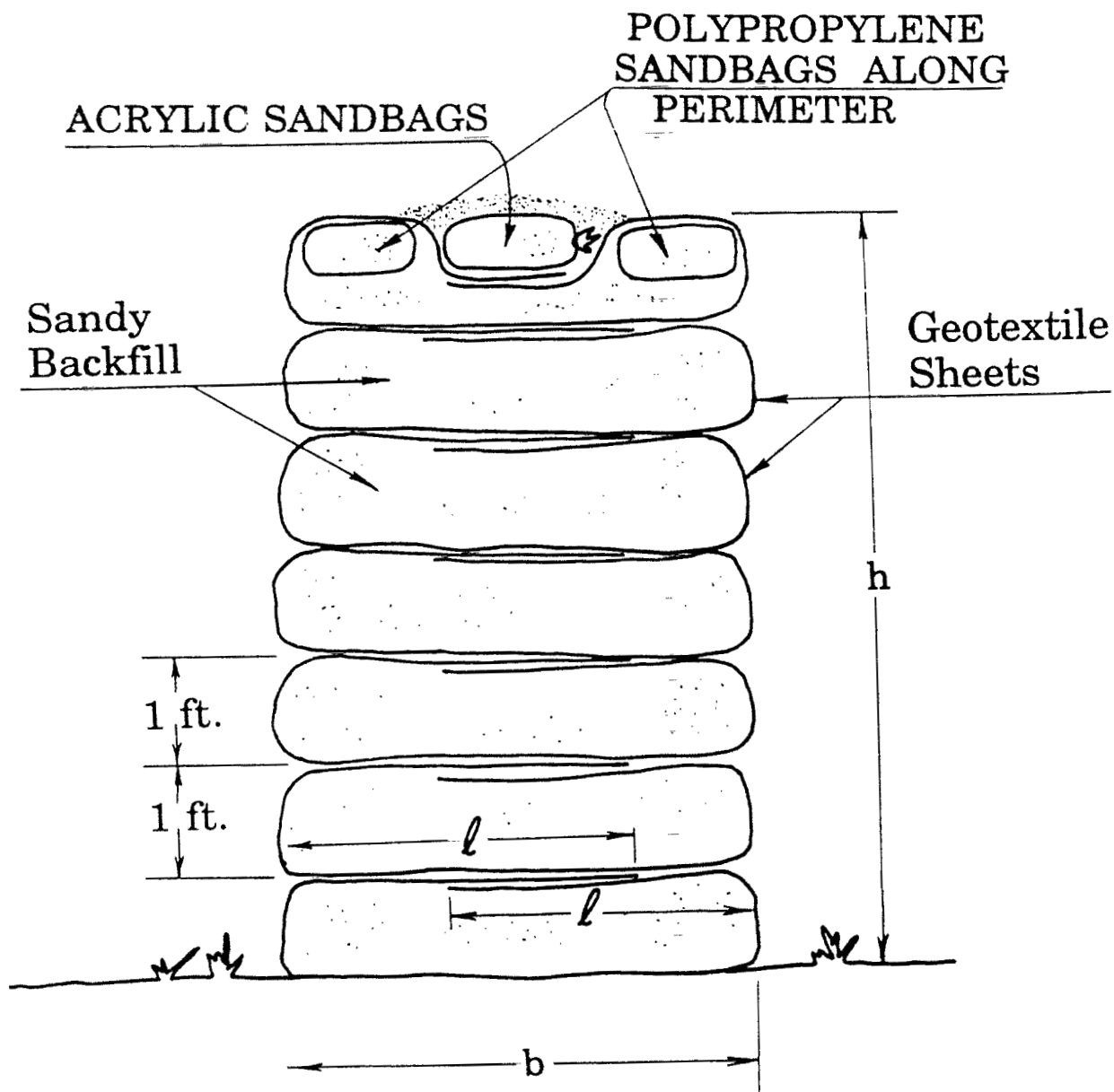


Figure 9. Geosynthetic Earth Filled Walls Last 20 Years And Are 3 Times Cheaper and 8 Times Quicker To Build Than Sand Bag Walls



Figure 10a. During Desert Storm, Wind Erosion Made Safe Field Storage Difficult

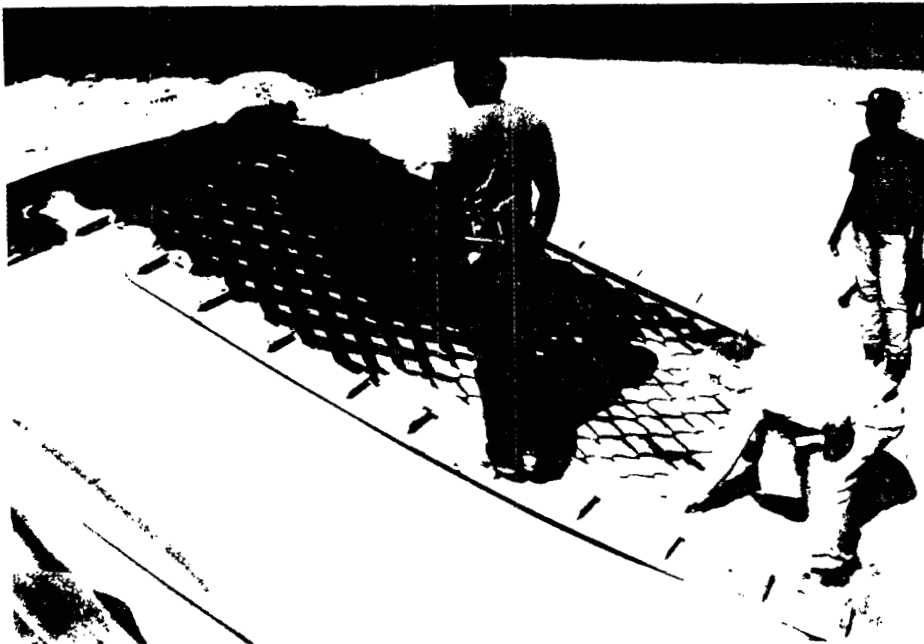


Figure 10b. The Erosion Control Project Identifies Solutions Like This Geoweb to Improve The Stability of Sand Berm Barricades